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Prime Hook National Wildlife Refuge Contaminants Study:  
Examining the Impacts of Clifton Cannery,  
A Potential Point Source

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U.S. Fish and Wildlife Service

Branch of Water Quality and

Environmental Contaminants

Chesapeake Bay Field Office

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### Acknowledgements

Samples were collected by Monica Maghini, David Sutherland, Peter McGowan, and Dan Murphy of the U.S. Fish and Wildlife Service Chesapeake Bay Field Office and George O'Shea of Prime Hook National Wildlife Refuge. The author thanks Patty McCawley of the Chesapeake Bay Field Office for preparing the final report manuscript. Bob Pennington, Bob Foley, and Fred Pinkney of the Chesapeake Bay Field Office reviewed the first draft of this report and John Moore of the U.S. Fish and Wildlife Service Patuxent Analytical Control Facility provided analytical oversight. Funding for this study was obtained from the U.S. Fish and Wildlife Service Region 5 Division of Refuges.

### INTRODUCTION

Prime Hook National Wildlife Refuge (refuge) is located near Delaware Bay in Sussex County, Delaware (Figure 1). The refuge encompasses approximately 8,800 acres of mostly marsh land, providing habitat for migratory birds (waterfowl, shore, and wading birds) and anadromous fish (herring, shad, and striped bass). Prime Hook Creek traverses the refuge from west to east, eventually discharging into Delaware Bay.

Clifton Canning Company operates a vegetable canning operation adjacent to Prime Hook Creek on the western boundary of the refuge. The cannery processes corn, peas, green beans, lima beans, potatoes, onions, and carrots. As part of the canning process, the vegetables are washed with water which is subsequently discharged into a holding lagoon. The water in the lagoon is applied to corn fields on cannery property via spray irrigation. The wastewater lagoon frequently overflows into an unnamed stream that empties into Prime Hook Creek on refuge lands approximately one half mile downstream from the cannery. This overflow often contains vegetable parts and other by-products of the canning process. Irrigation effluent has been observed spraying directly onto refuge property as well as accumulating in standing pools in the corn fields which overflow onto refuge lands during precipitation events. A 1989 analysis of cannery effluent (Technical Testing Laboratories 1989) found levels of copper (0.03 ppm) and zinc (0.12 ppm) that were at or above acute and chronic

ambient water quality criteria for freshwater organisms (USEPA 1986). In the 1989 analysis, detection limits for some analytes like lead exceeded ambient water quality criteria. Discharges to the environment from canning processes can lead to contamination of aquatic and terrestrial substrates resulting in contamination of wildlife food sources.

The objective of this survey was to determine whether cannery operations are leading to accumulations of contaminants in refuge sediments and soils. In 1992, at the request of the refuge manager, U.S. Fish and Wildlife Service (Service) Chesapeake Bay Field Office personnel collected sediment samples from the unnamed stream, soil samples from areas where spray irrigation water was washing onto refuge lands, and water samples from areas of standing irrigation water in cannery vegetable fields adjacent to refuge property. Sample locations were chosen in order to verify a suspected environmental pathway of cannery effluent to receptors on Service lands. Samples were analyzed for metals, polycyclic aromatic hydrocarbons (PAH), and organochlorine pesticides.

## MATERIALS AND METHODS

### Sample Collection and Analysis

Samples were collected on October 2, 1992. Four composite sediment samples were collected from an unnamed creek downstream from the cannery near its mouth at Prime Hook Creek (Figure 2). Sediment samples were collected at 100 foot intervals along the stream and consisted of several small grab samples. The grab samples were collected with a plastic scoop, mixed by hand in a polyethylene pan, placed in 500-mL glass bottles, and labelled with sample numbers PHSE01, PHSE02, PHSE03, and PHSE04. In addition to samples collected near the cannery, additional sediment samples were collected from areas of Delaware that receive minimal influence from contaminants. Background sediment samples were collected in duplicate at Woodland Beach Wildlife Area (WOOD01 and WOOD02); the Mahon River at Bombay Hook National Wildlife Refuge (PMAH01 and PMAH02) in Kent County, Delaware; and upstream from the Broadkill River inlet (BK01 and BK02) in Sussex County, Delaware on December 7, 1992. Background sediments were collected using a ponar dredge, and handled in the same manner as the Prime Hook sediment samples.

Seven soil composite samples were collected from areas where spray irrigation effluent washes onto refuge property (Figure 2). The soil samples were collected in eroded areas on refuge lands adjacent to the corn fields that receive spray irrigation. Soil surfaces in these areas were eroded by run-off originating from the corn fields. Soil samples were collected in the same manner as the sediment samples. Soil sample bottles were labelled with sample numbers PHWO01, PHWO02, PHWO03, PHWO04, PHWO05, PHWO06, and PHWO07. Soil and sediment samples were placed on ice in the field and frozen upon return to the field office.

One water sample was collected from each of three standing water sites located on cannery property in the vegetable fields directly adjacent to refuge lands (Figure 2). Samples were collected by dipping 1-L glass jars below the water surface. A field blank consisted of a 1-L glass jar containing distilled water. Samples from the standing water sites were labelled with sample numbers PHWA01, PHWA03, and PHWA04 and the field blank was labelled with sample number PHWA02. Water samples were fixed with nitric acid, placed on ice in the field, and refrigerated upon return to the field

office.

Soil and sediment samples were stored at -20C and water samples were stored at 4C prior to shipment to the analytical laboratory (Geochemical and Environmental Research Group, College Station, Texas). Metals, organochlorine pesticide, and polynuclear aromatic hydrocarbon (PAH) analyses were performed on all samples. In addition, total organic carbon (TOC) and grain size measurements were made on sediment and soil samples and acid volatile sulfide determinations were performed on the sediment samples. All analyses were performed following laboratory protocols as specified by the Patuxent Analytical Control Facility (PACF).

### Quality Assurance/Quality Control

The PACF reviewed results of analyses for organochlorine pesticides, PAH, and trace metals to evaluate the performance of the analytical laboratory. Approximately 26% of the samples for metal analysis and 13% of the samples for organic analysis were analyzed in duplicate. Percent recovery in these samples was determined by spiking with a known amount of analyte. Standard reference material (National Research Council of Canada Standard Reference Material) was analyzed with the metal samples to verify the methods. All laboratory analyses met the quality control requirements of the PACF.

### Data Analysis

Because the sample size in this study was small, statistical analyses were not performed. Water, sediment, and soil results were compared to existing criteria and background information to determine whether they were greater than or less than levels denoting contamination and possible adverse effects to wildlife. Non-detects are preceded by "<" in the tables and appendices and were not used to calculate average concentrations. Percent fines for sediments collected from the unnamed tributary to Prime Hook Creek ranged from 29.9% to 50.9% and percent fines in background samples ranged from 35.17% to 97.7%. Due to the wide range of grain size results, sediment concentrations in the unnamed creek were compared to background using grain size normalized data (Appendix A-11). Because of greater surface area for adsorption, fine-grained sediments accumulate more contaminants (NOAA 1991). The data were normalized to account for differences in grain size. Total PAH values in Table 1 were determined by summing all detected PAH's.

## RESULTS

### Sediment Data

Analytical results for sediment samples collected from the unnamed creek and "clean" Delaware background areas are compared to ER-M levels in Table 1. The ER-M is the 50th percentile concentration associated with adverse biological effects (Long and Morgan 1990). The ER-M is defined as the concentration above which toxic effects usually or frequently occur. Concentrations of all metals detected in the unnamed creek sediment samples were less than ER-M levels (Long and Morgan 1990) (Table 1). Two of four sediment samples from the unnamed creek contained p,p'-DDD concentrations that exceeded the ER-M value of 0.020 ppm. Because no DDE or DDT were found in

sediments, the ER-M for total DDT (the sum of DDT, DDD, and DDE) of 0.35 ppm was not exceeded. The mean concentration for the two samples with detectable levels of p,p'-DDD was 0.057 ppm. While total PAH's did not exceed the ER-M value, one naturally occurring PAH, perylene, was found to exceed apparent effects thresholds (AET) for amphipods (0.23 ppm) and bivalve larvae (0.095 ppm) (Long and Morgan 1990). The AET is a concentration above which statistically significant biological effects always occur. The mean perylene concentration was 0.341 ppm with two out of four samples exceeding the amphipod AET and all four samples exceeding the bivalve larvae AET. There is no ER-M value for perylene at this time.

Grain size normalized unnamed creek sediment concentrations and grain size normalized Delaware background sediment concentrations are compared in Table 2. Of the detectable analytes found in the unnamed creek sediments, concentrations of six metals and three organic compounds were greater than those found in the Delaware background sediments. Metals found at greater concentrations than Delaware background levels were barium, beryllium, cadmium, mercury, lead, and strontium. Organic compounds exceeding background were p,p'-DDD, perylene, and total PAH.

#### Ponded Water Data

Analytical results for samples collected from three ponded water areas on Clifton Cannery irrigation fields adjacent to Prime Hook lands were compared with Ambient Water Quality Criteria (AWQC) (Table 3) (USEPA 1986, 1988). The AWQC lists dissolved concentrations. In this study, water samples were analyzed for total analytes (dissolved and undissolved). Data were compared to the AWQC to identify levels that were possibly elevated. Mean concentrations of iron and zinc exceeded acute and chronic toxicity criteria for freshwater organisms. The mean lead level in ponded water exceeded freshwater chronic toxicity criteria. Freshwater acute and chronic copper criteria were exceeded in one sample and two other samples contained copper in concentrations that exceeded the freshwater chronic level. Aluminum was detected in one sample at a concentration of 1.51 ppm, exceeding both acute and chronic criteria. Concentrations of iron and aluminum were probably particle associated and, therefore, less available to biota. Organic contaminants were not detected in ponded water samples.

#### Soil Data

Analytical results for soil samples from areas on Prime Hook lands that receive spray irrigation and spray irrigation run-off from the cannery were compared to North Delaware, South Delaware, and Eastern U.S. background levels (Shacklette and Boerngen 1984) and Dutch background levels (Beyer 1990) (Table 4). Average soil concentrations of lead, mercury, manganese, and zinc exceeded Delaware and Eastern U.S. background levels. Lead and zinc were found at concentrations that were up to 7 to 10 times higher than Delaware background, respectively. Mean levels of arsenic exceeded Delaware background soil levels but not Eastern U.S. background concentrations. Dieldrin, p,p'-DDE, and total PAH were detected in soil samples at concentrations that did not exceed Dutch background levels (U.S. background levels for these analytes were not available at the time of this report). No analytes were detected in soils at concentrations exceeding Dutch threshold levels requiring immediate clean-up because of moderate or heavy contamination (Beyer 1990).

### DISCUSSION

This study has demonstrated that there is a clear pathway from the contaminated spray irrigation effluents that originate on Clifton Cannery property to soils on adjacent lands of Prime Hook NWR. Total concentrations of aluminum, copper, iron, lead, and zinc in ponded water on the cannery spray irrigation field exceeded dissolved levels listed in the Ambient Water Quality Criteria for freshwater organisms (USEPA 1986, 1988). Soils on impacted areas of Prime Hook refuge were found to contain levels of arsenic, mercury, manganese, lead, and zinc that exceeded background levels. Lead and zinc were found at concentrations that were up to 7 and 10 times higher than Delaware background, respectively. Levels this high above background probably originated from a local source, the nearest of which is the cannery. If the levels of metals in refuge soils were the result of atmospheric deposition from more remote sources, they would more closely reflect Delaware background levels. The fact that there were high levels of lead and zinc in cannery ponded water suggests that high levels in impacted Prime Hook soils are the result of cannery wastewater disposal practices. In 1989, copper and zinc were found in cannery effluent at levels that exceeded ambient water criteria for aquatic life, indicating that elevated metal concentrations in cannery effluent occurred at an earlier time and continue to be a threat to the refuge.

In sediments from the unnamed tributary of Prime Hook Creek, concentrations of the PAH perylene and p,p'-DDD exceeded concentrations above which toxic effects usually occur (Long and Morgan 1990). DDD is a breakdown product of the organochlorine pesticide DDT. In the United States, DDT was once used to control insects on 334 agricultural products (U.S. Department of Health and Human Services 1994). While the use of DDT was banned in North America in 1969, this pesticide and its breakdown products DDD and DDE have long half-lives in sediments and continue to be a source of contamination to the aquatic environment (Moore and Ramamoorthy 1984). In aquatic systems, DDD has been found to biomagnify through the food chain (U.S. Department of Health and Human Services 1994). Toxic effects of DDD to sediment invertebrates could have adverse effects on fish and waterfowl species by decreasing food supply or by ingestion of contaminated food organisms. Perylene sometimes occurs as a result of natural processes such as the diagenesis of terrestrial pigments (Windsor et al. 1977). While perylene concentrations exceeded the apparent effects thresholds for amphipods and bivalve larvae, it is uncertain whether this is the result of anthropogenic inputs.

## CONCLUSION

The results of this study and previous effluent data are a strong indication that the Clifton Cannery contributes to the deposition of effluent borne contaminants on Prime Hook National Wildlife Refuge lands. Based on these findings, the Service recommends that the Cannery install a treatment facility that adequately removes contaminants to environmentally safe levels. These levels should be included in a NPDES permit that is made available to the Service for review prior to implementation.

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June 6, 1996

Mr. George O'Shea

Prime Hook National Wildlife Refuge

Rt. 3, P.O. Box 195

Milton, DE 19968

RE: Prime Hook National Wildlife Refuge Contaminants Study: Examining the Impacts of Clifton Cannery, A Potential Point Source

Dear Mr. O'Shea:

Enclosed are two copies of the final version of the report, *Prime Hook National Wildlife Refuge Contaminants Study: Examining the Impacts of Clifton Cannery, a Potential Point Source*. This report was prepared by Dan Murphy of the Chesapeake Bay Field Office under Regional Study ID number 5N07.

The results of this study suggest that there could be a contaminant pathway from Clifton Cannery to natural resources on Prime Hook National Wildlife Refuge, Delaware, via spray irrigation effluents originating at the cannery. However, this study is not conclusive. Please contact Dan Murphy at (410) 573-4579 if you have any questions.

Sincerely,

Robert J. Pennington, Chief

Branch of Water Quality and Environmental Contaminants

Enclosure

June 6, 1996

Memorandum

To: Environmental Contaminants Coordinator, Region 5, Ecological Services, Hadley, MA

From: Chief, Branch of Water Quality and Environmental Contaminants, Chesapeake Bay Field Office, Annapolis, MD

Subject: Prime Hook National Wildlife Refuge Contaminants Study: Examining the Impacts of Clifton Cannery, a Potential Point Source

Attached is a copy of the final version of the report, *Prime Hook National Wildlife Refuge Contaminants Study: Examining the Impacts of Clifton Cannery, a Potential Point Source*. This report was prepared by Dan Murphy of the Chesapeake Bay Field Office under Regional Study ID number 5N07.

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Robert J. Pennington

Attachment

Murphy

McCawley

Foley

Pennington

FILENAME:PrimeH.rep (&cover letters)

Dmurphy:pam:4/5:4/12:6/6/96

Ecdisk